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RESEARCH MEMORANDUM

THE IMPACT OF THE ADJUSTED SCALING OF ASVAB FORMS 11, 12, and 13

Gary E. Horne

A Division of CNA *Hudson Institute*

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1. Enclosure (1) is forwarded as a matter of possible interest.

2. The Armed Services Vocational Aptitude Battery (ASVAB) is used by all branches of the armed services to measure the mental aptitudes of applicants for enlistment. ASVAB forms 11, 12, and 13 were introduced in October 1984. In July 1986 the conversion tables used to convert the number of correct answers into Armed Forces Qualification Test (AFQT) scores, composite scores, and subtest standard scores were changed. This Research Memorandum examines the likely impact of this change on ASVAB scores of Marine Corps applicants.

William H. Sims
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CRM 86-195 / September 1986

THE IMPACT OF THE ADJUSTED SCALING OF ASVAB FORMS 11, 12, AND 13

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ABSTRACT

New scales for ASVAB forms 11, 12, and 13 have been implemented. This research memorandum describes the impact of this adjusted scaling on scores for FY 1985 Marine Corps applicants. In addition, the initial and adjusted scalings for each ASVAB subtest are compared.

EXECUTIVE SUMMARY

The Armed Services Vocational Aptitude Battery (ASVAB) is used by all branches of the armed services to measure the mental aptitudes of applicants for enlistment. When new forms of the ASVAB are introduced they are equated to a reference test so that scores from the new forms can be placed on the same scale as previous forms.

The initial scaling of ASVAB forms 11, 12, and 13 was based on data resulting from the administration of these forms in Recruit Training Centers and Military Entrance Processing Stations during the first 3 months of 1983. The scaling was adjusted in July 1986 based on data gathered during the Initial Operational Test and Evaluation (IOT&E) of these forms in October and November 1984. The adjustment was necessary because the print format of the test booklets was changed between the initial scaling of ASVAB forms 11, 12, and 13 in 1983 and their introduction as operational forms in 1984. This report describes the impact of the change in scaling from the initial calibration to the adjusted scaling based on the IOT&E.

The Armed Forces Qualification Test (AFQT) is a composite of certain ASVAB subtests. The AFQT is used by all services to help establish the qualifications of applicants for enlistment. Some AFQT percentiles are especially significant because they are widely used by the services in making selection and classification decisions; these include the percentile scores of 21 (used by several services as the minimum standard for acceptance), 31 (the level below which services attempt to limit the number of accessions), and 50 (the minimum level at which enlistment guarantees and bonuses are given). Comparison of the scores at these percentiles for FY 1985 Marine Corps applicants shows that more applicants qualify under the adjusted scaling than under the initial scaling (see table I).

Other composites are used by the services to determine the qualifications of enlistees for training in various areas. Four aptitude composites of this type were examined to determine the impact of the adjusted scaling on scores for the FY 1985 Marine Corps applicants. The results show an increase in the number of qualifying applicants for one composite, a decrease for another, and almost no change for the remaining two composites. These results are summarized in table II.

TABLE I

PERCENTAGE OF FY 1985 MARINE CORPS APPLICANTS QUALIFYING AT SIGNIFICANT AFQT PERCENTILE SCORES UNDER THE INITIAL VERSUS THE ADJUSTED SCALING

AFQT percentile score								
21			31			50		
Initial	Adjusted	Change	Initial	Adjusted	Change	Initial	Adjusted	Change
91.5	92.6	+1.1	81.3	82.8	+1.5	50.0	52.1	+2.1

TABLE II

PERCENTAGE OF FY 1985 MARINE CORPS APPLICANTS QUALIFYING AT A COMPOSITE STANDARD SCORE OF 100 UNDER THE INITIAL VERSUS THE ADJUSTED SCALING

	Percent qualifying at standard score of 100		
Aptitude composite	Initial	Adjusted	Change
General Technical	58.4	60.8	+2.4
Electronics Repair	56.4	54.4	−2.0
Mechanical Maintenance	59.4	59.4	0.0
Clerical	58.9	58.5	−0.4

The initial and adjusted scalings were also compared for each subtest using the actual conversion tables (and thus not any particular sample of applicants). These comparisons showed that scores were noticeably higher under the adjusted scaling for the Word Knowledge, Numerical Operations, and Mechanical Comprehension subtests. Scores were noticeably lower under the adjusted scaling for the General Science, Coding Speed, and Electronics Information subtests.

In conclusion, conversion tables for many of the ASVAB subtests and composites changed by small but noticeable amounts under the adjusted scaling for forms 11, 12, and 13.

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INTRODUCTION

The Armed Services Vocational Aptitude Battery (ASVAB) is used by all branches of the armed services to measure the mental aptitudes of applicants for enlistment. The ASVAB consists of ten subtests that are combined in various ways to form composites. These subtests are General Science, Arithmetic Reasoning, Word Knowledge, Paragraph Comprehension, Numerical Operations, Coding Speed, Auto and Shop Information, Mathematics Knowledge, Mechanical Comprehension, and Electronics Information.

The Armed Forces Qualification Test (AFQT) is a composite computed from scores on four of the ASVAB subtests. The AFQT is designed to be an indicator of general trainability and is used to screen out applicants at lower ability levels and to help determine eligibility for enlistment guarantees and bonuses.

Aptitude composites, formed by using scores on two or more ASVAB subtests, are used by the services to determine the qualifications of enlistees for training in various areas. Aptitude composites used by the Marine Corps are the General Technical (GT) composite, the Electronics Repair (EL) composite, the Mechanical Maintenance (MM) composite, and the Clerical (CL) composite.

New forms of the ASVAB are developed periodically to improve test security and replace unwanted test items. When new forms are introduced they are equated to a reference test so that scores from the new forms can be placed on the same score scale. This scaling allows the services to report and compare scores achieved on different forms using a common score scale or metric [1]. The current metric is based on a weighted sample of American youth, ages 18 to 23, called the 1980 Youth Population.

The initial scaling of ASVAB forms 11, 12, and 13 was based on data resulting from the administration of these forms in Recruit Training Centers (RTCs) and Military Entrance Processing Stations (MEPSs) during the first 3 months of 1983. Analysis of data gathered during the first 2 months the new forms were used in an operational setting, October and November 1984, showed that AFQT scores obtained on the new forms should be adjusted upward by approximately 2 points, primarily because of deflated scores on the Numerical Operations subtest. This adjustment was required because between the time of the initial scaling of ASVAB forms 11, 12, and 13 in 1983 and their introduction as operational forms in 1984, the print format of the

test booklets was changed, and the revised format affected applicant performance. (See [2] for further details on this subject.)

The purpose of this memorandum is to describe the impact of the change in scaling between the initial calibration based on 1983 RTC and MEPS data and the adjusted scaling based on the 1984 Initial Operational Test and Evaluation (IOT&E) of ASVAB forms 11, 12, and 13.

COMPARISONS OF SCALINGS

The initial and adjusted scalings were compared in two different ways. First, AFQT and aptitude composite scores for a sample of military applicants were calculated using both the initial and adjusted scalings, and the changes in score distributions were noted. Second, the actual conversion tables for the initial and adjusted scalings were used to make direct comparisons between the scalings by subtest.

ASVAB scores were obtained for all FY 1985 Marine Corps applicants. The scores for only those people who were applying for the first time in FY 1985 and who were applying for active-duty (not reserve) status were used in this study. A total of 53,914 applicants tested on ASVAB forms 11a, 11b, 12a, 12b, 13a, or 13b fit these specifications.

The raw subtest scores from the FY 1985 Marine Corps applicants were placed on the 1980 Youth Population metric using both the initial scaling and the adjusted scaling. The method used for placing the raw scores on the 1980 metric for each of the subtests for both the initial and adjusted scaling is described in the appendix.

After the subtest scores were placed on the 1980 metric, AFQT scores were calculated for the 53,914 applicants. The percentage of applicants in the AFQT categories for the initial and the adjusted scalings were then compared. Scores for both equatings were also calculated for the GT, EL, MM, and CL composites in standard score form (mean of 100, standard deviation of 20). The percentage of applicants in various score ranges for the initial and adjusted scalings were then compared.

To characterize the impact of the adjusted scaling on each subtest, the actual conversion tables for ASVAB forms 11a, 11b, 12b, 13a, and 13b provided in [3] and [4] were used. For each possible raw score on each subtest, the standard score equivalent was found for the initial scaling in [3] and the

adjusted scaling in [4]. The scores were then compared. No specific set of applicants was used in this comparison, just the actual scores.

RESULTS

The results of the comparison between the initial and the adjusted scalings for FY 1985 Marine Corps applicants are depicted in figures 1 through 5. Figure 1 shows the AFQT results by AFQT category. Note that category I corresponds to AFQT percentile scores of 93 through 99; category II, 65 through 92; category IIIA, 50 through 64; category IIIB, 31 through 49; category IVA, 21 through 30; category IVB (and IVC), 10 through 20; and category V, 1 through 9. Figures 2 through 5 show similar results for the GT, EL, MM, and CL composites. Table 1 summarizes the results for the AFQT and the four Marine Corps composites.

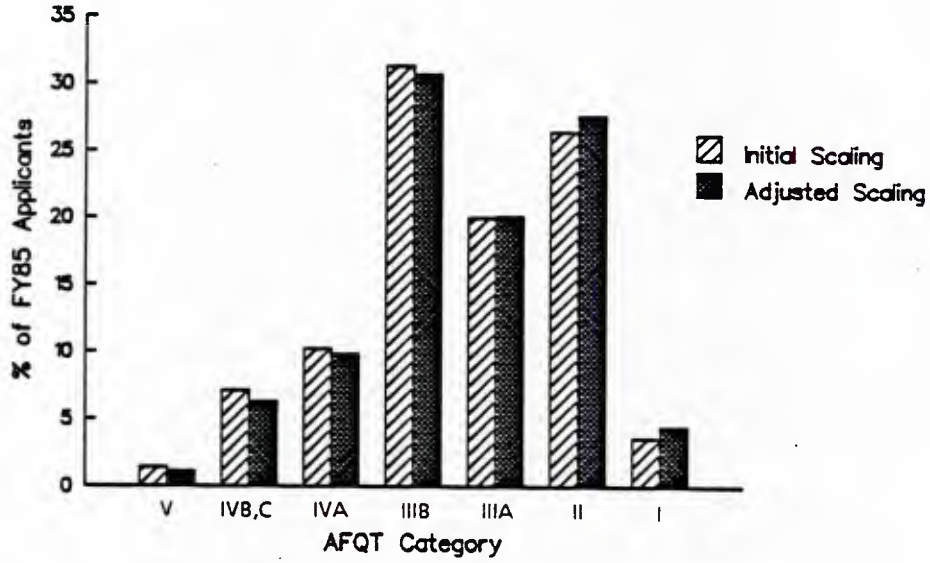

FIG. 1: PERCENTAGE OF FY 1985 APPLICANTS IN EACH AFQT CATEGORY

The AFQT percentile scores listed in table 1—10, 21, 31, 50, 65, and 93—are AFQT category boundaries. These scores, especially 21 (minimum standard for acceptance into the Marine Corps), 31 (the level below which services attempt to limit the number of accessions), and 50 (the minimum level at which enlistment guarantees and bonuses are given), are widely used by the services in making selection and classification decisions. At the percentile score of 21, 1.1 percent more applicants would have qualified under the adjusted scaling than under the initial scaling. The increases for percentile levels of 31 and 50 are 1.5 percent and 2.1 percent, respectively. Thus, at the important percentile score of 31, 82.8 percent of the FY 1985 Marine Corps

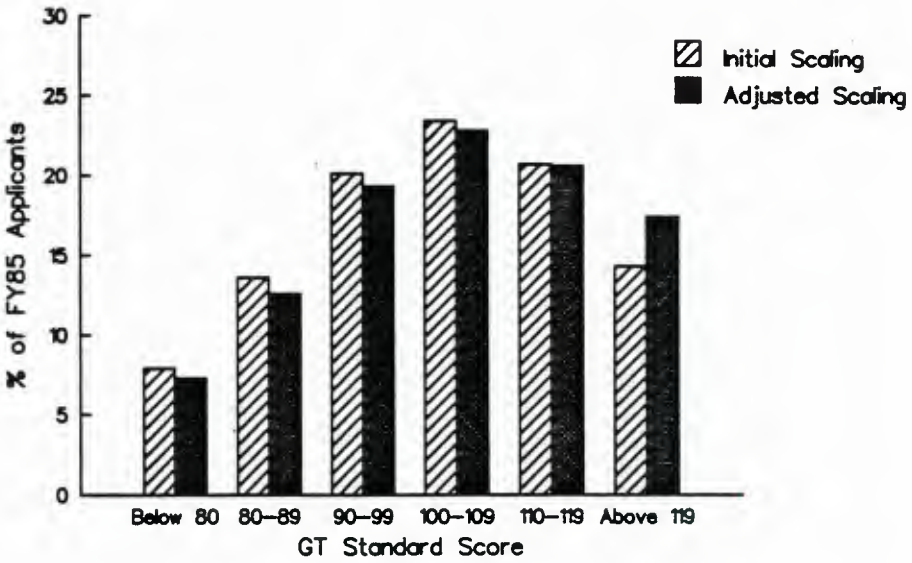

FIG. 2: PERCENTAGE OF FY 1985 APPLICANTS IN GT COMPOSITE STANDARD SCORE INTERVALS

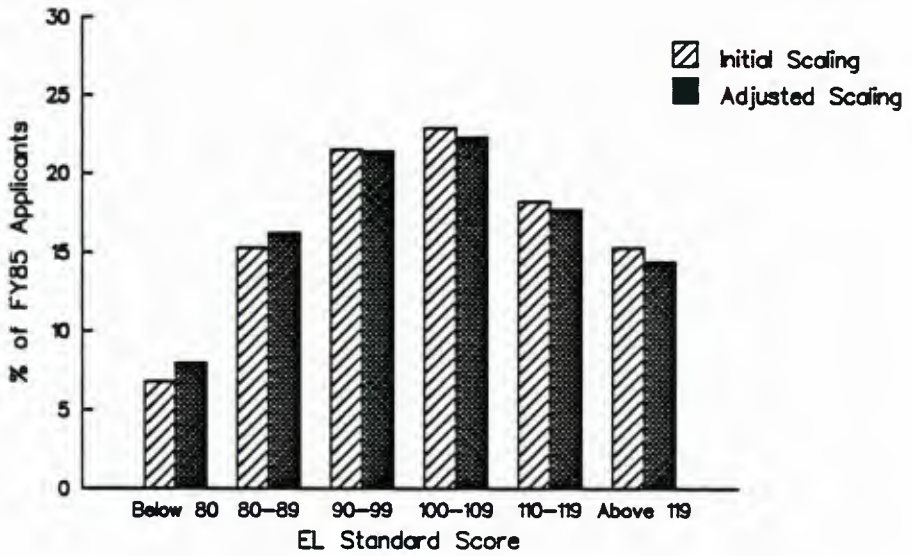

FIG. 3: PERCENTAGE OF FY 1985 APPLICANTS IN EL COMPOSITE STANDARD SCORE INTERVALS

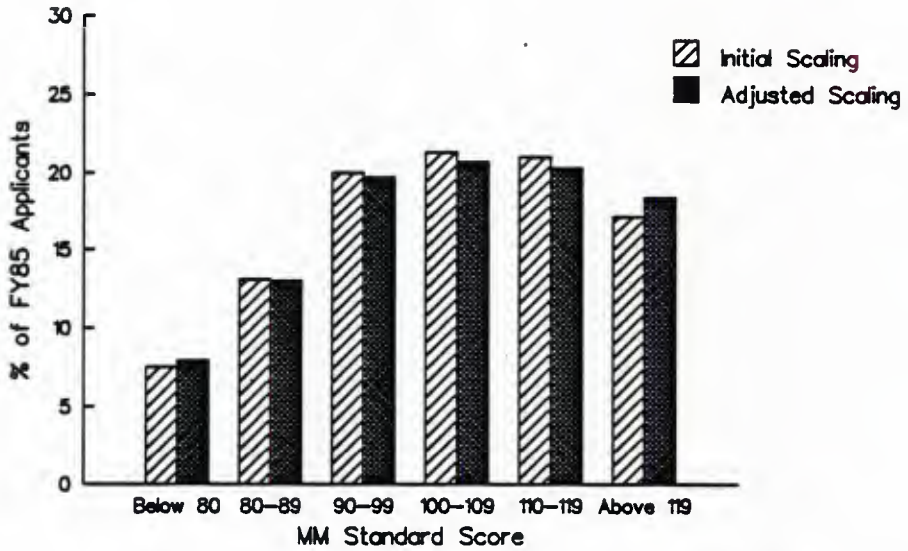

FIG. 4: PERCENTAGE OF FY 1985 APPLICANTS IN MM COMPOSITE STANDARD SCORE INTERVALS

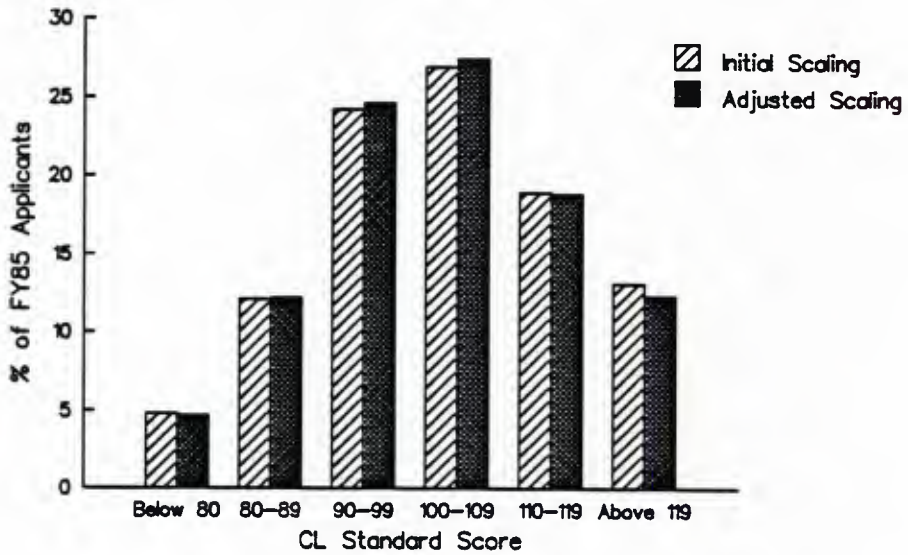

FIG. 5: PERCENTAGE OF FY 1985 APPLICANTS IN CL COMPOSITE STANDARD SCORE INTERVALS

TABLE 1

INITIAL SCALING VERSUS ADJUSTED SCALING FOR ASVAB FORMS 11, 12, AND 13
FOR FY 1985 MARINE CORPS APPLICANTS

AFQT: Percent scoring at or above percentile score

10		21		31		50		65		93	
Initial	Adjusted	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted
98.6	98.9	91.5	92.6	81.3	82.8	50.0	52.1	30.0	32.0	3.6	4.4

Composites: Percent scoring at or above standard score

	80		90		100		110		120	
Composite	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted
GT	92.1	92.7	78.5	80.1	58.4	60.8	35.0	38.0	14.3	17.4
EL	93.2	92.0	77.9	75.8	56.4	54.4	33.5	32.1	15.3	14.4
MM	92.5	92.1	79.4	79.1	59.4	59.4	38.1	38.7	17.1	18.4
CL	95.2	95.3	83.1	83.1	58.9	58.5	32.0	31.1	13.1	12.3

applicants would have qualified under the adjusted scaling whereas 81.3 percent qualified under the initial scaling. For the AFQT percentile score of 50, the percentages qualifying are 52.1 percent (adjusted scaling) compared to 50.0 percent (initial scaling).

For the GT composite, more applicants would have achieved the standard scores of 80, 90, 100, 110, and 120 under the adjusted scaling. For the EL composite, fewer applicants would have achieved these scores under the adjusted scaling. The MM and CL composites showed little difference between the initial and the adjusted scaling. In terms of percentages at the mean level (standard score of 100), the results in table 1 show that 2.4 percent more applicants qualified under the adjusted scaling on GT, 2.0 percent fewer on EL, and 0.4 percent fewer on CL. There was no difference between the initial and adjusted scalings for MM.

For each raw score for each subtest, the corresponding standard scores for the initial scaling and the adjusted scaling were compared. These scores are plotted in figures 6 through 15. In each figure the horizontal axis represents the initial scaling and the vertical axis represents the adjusted (IOT&E-based) scaling. For each possible raw score, a point was plotted with the x-coordinate equal to the standard score equivalent under the initial scaling and the y-coordinate equal to the standard score equivalent under the adjusted scaling. For example, a raw score of 16 on the General Science subtest is equivalent to a standard score of 50 under the initial scaling and 49 under the adjusted scaling. Therefore, the point in figure 6 for the raw score of 16 is at (50, 49). This point and all others in this figure fall on or below the reference line drawn through points with equal first and second coordinates, indicating that scores decline on the General Science subtest under the adjusted scaling compared with the initial scaling. If there was no difference between the initial and the adjusted scaling, the points would all fall on the reference line.

Figures 6 through 15 show that standard scores are noticeably higher under the adjusted scaling on the Word Knowledge, Numerical Operations, and Mechanical Comprehension subtests. Scores are noticeably lower on the General Science, Coding Speed, and Electronics Information subtests. Scores on the remaining subtests are approximately the same.

Table 2 shows which ASVAB subtests are included in each composite examined in this report. This table and the results shown in figures 6 through 15 reveal why the composite results changed in the way they did under the adjusted scaling. Scores on the AFQT were higher under the adjusted scaling

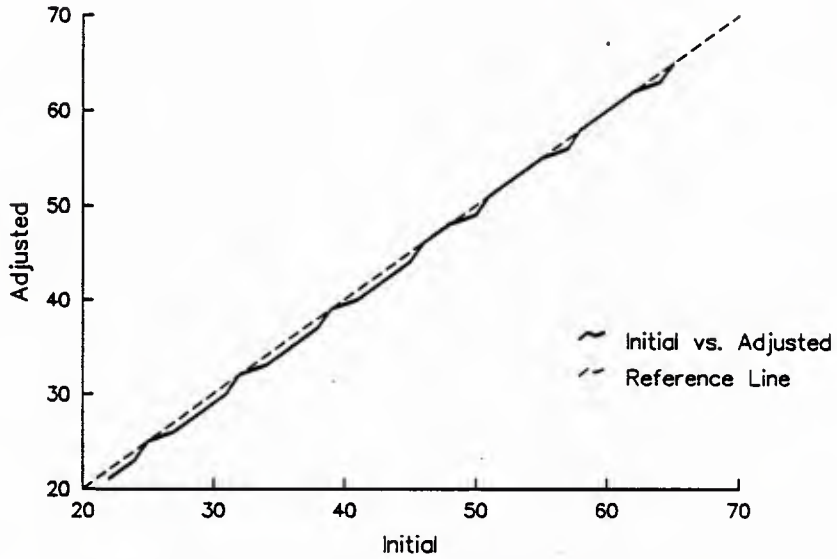

FIG. 6: INITIAL vs. ADJUSTED SCALING FOR GENERAL SCIENCE SUBTEST

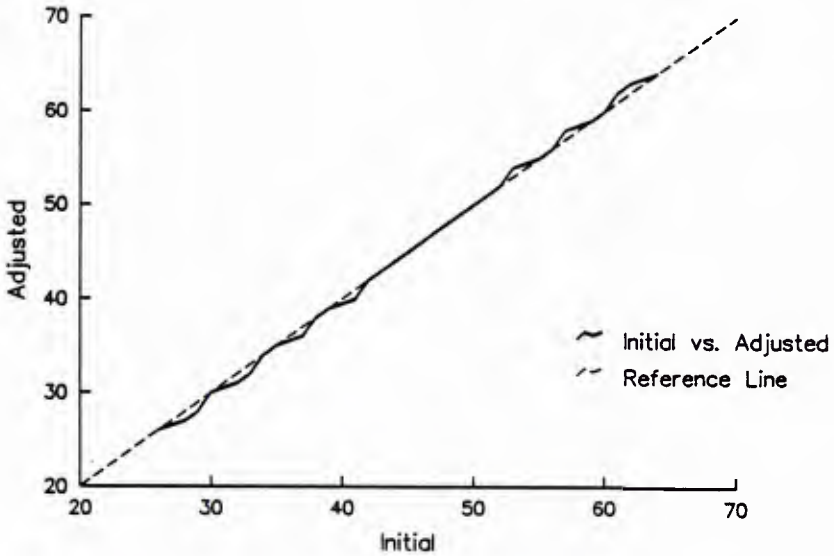

FIG. 7: INITIAL vs. ADJUSTED SCALING FOR ARITHMETIC REASONING SUBTEST

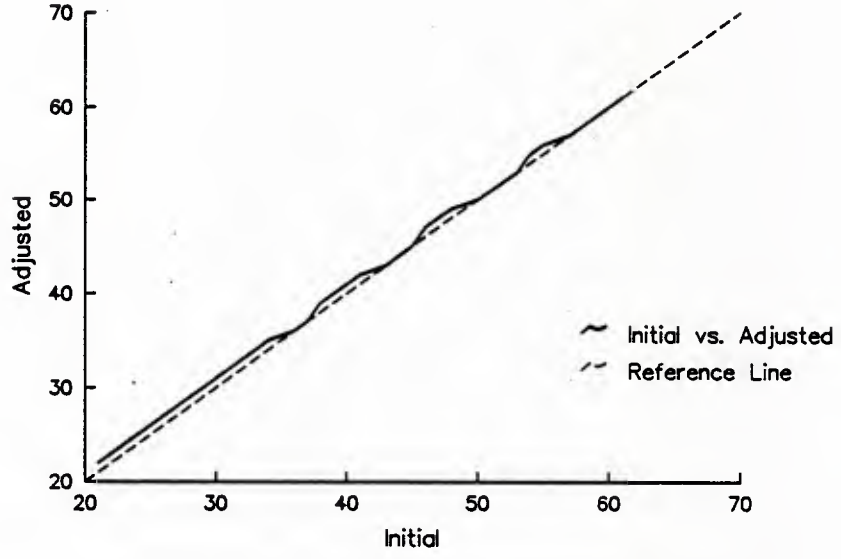

FIG. 8: INITIAL vs. ADJUSTED SCALING FOR WORD KNOWLEDGE SUBTEST

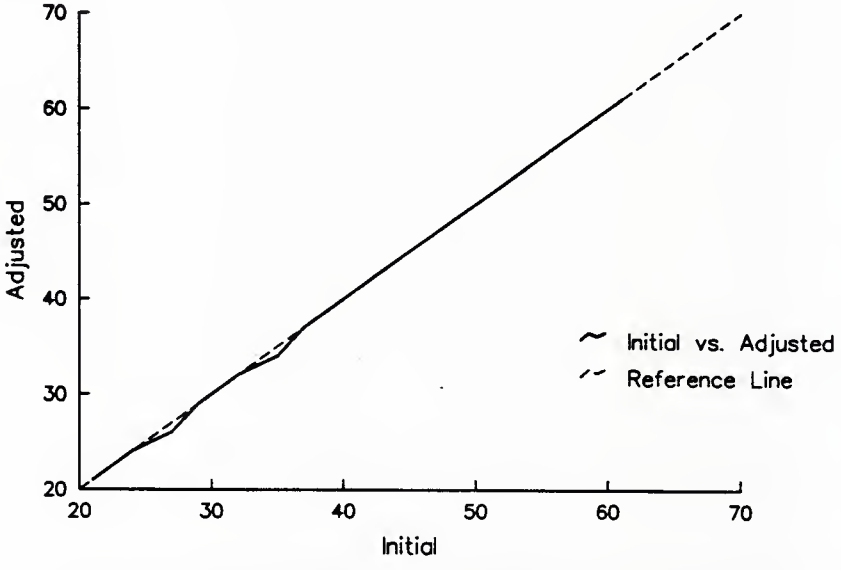

FIG. 9: INITIAL vs. ADJUSTED SCALING FOR PARAGRAPH COMPREHENSION SUBTEST

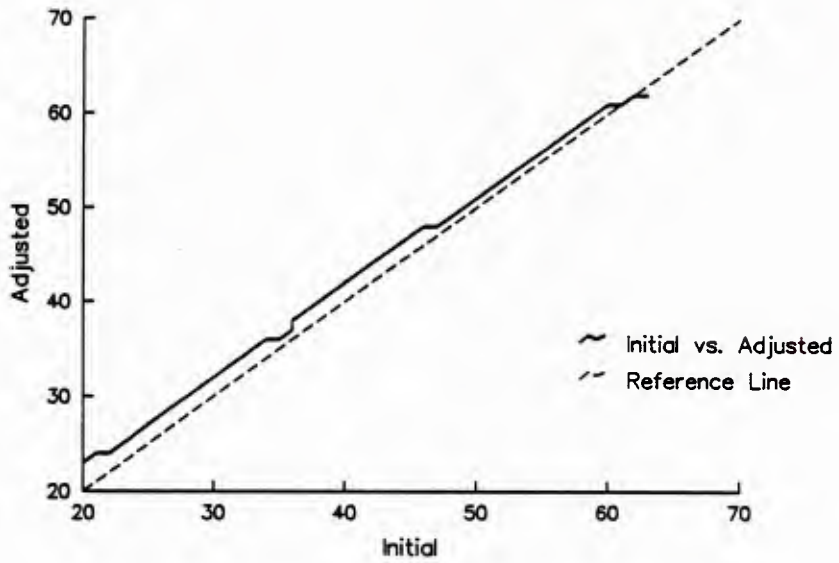

FIG. 10: INITIAL vs. ADJUSTED SCALING FOR NUMERICAL OPERATIONS SUBTEST

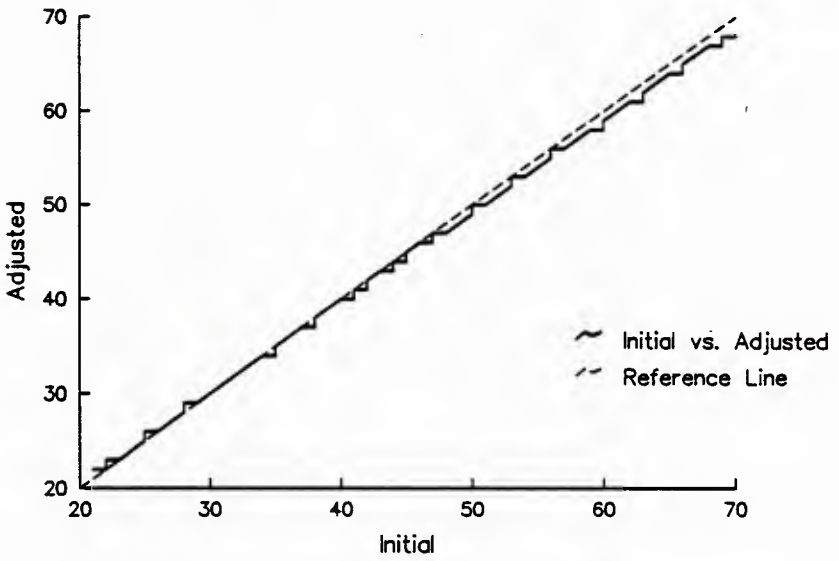

FIG. 11: INITIAL vs. ADJUSTED SCALING FOR CODING SPEED SUBTEST

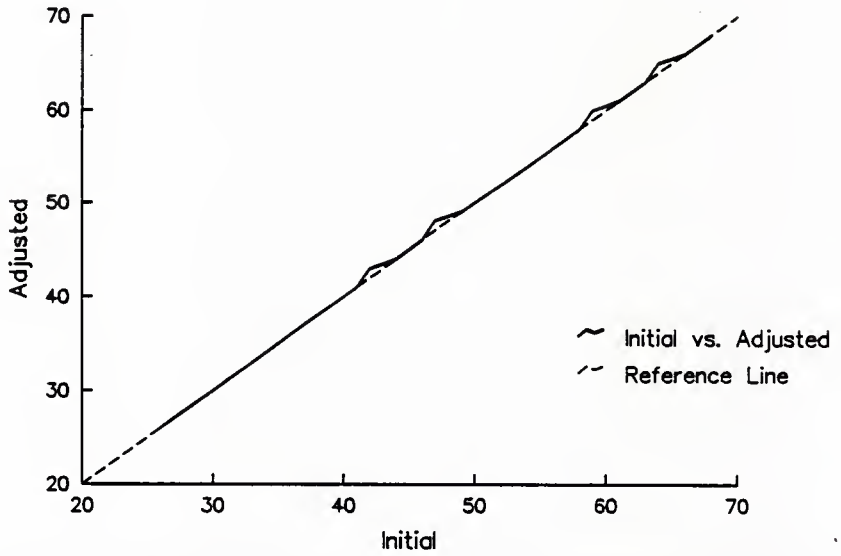

FIG. 12: INITIAL vs. ADJUSTED SCALING FOR AUTO AND SHOP INFORMATION SUBTEST

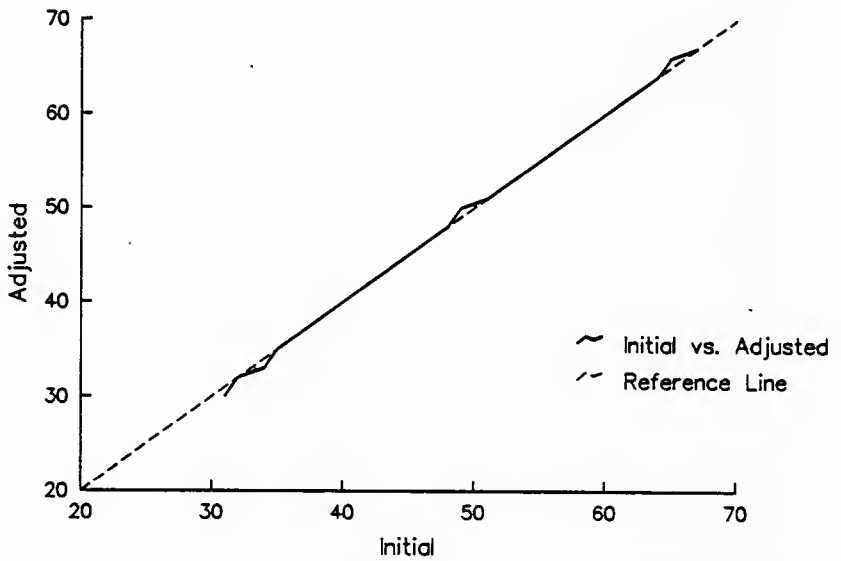

FIG. 13: INITIAL vs. ADJUSTED SCALING FOR MATHEMATICS KNOWLEDGE SUBTEST

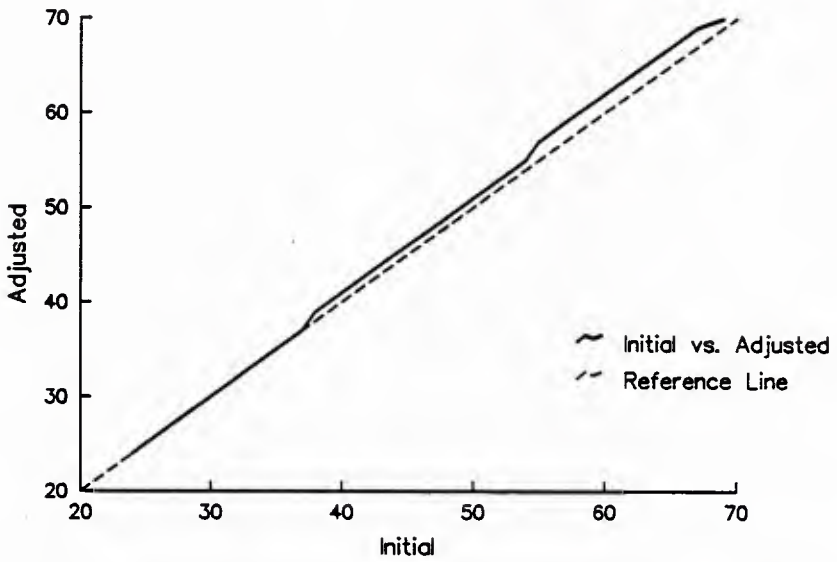

FIG. 14: INITIAL vs. ADJUSTED SCALING FOR MECHANICAL COMPREHENSION SUBTEST

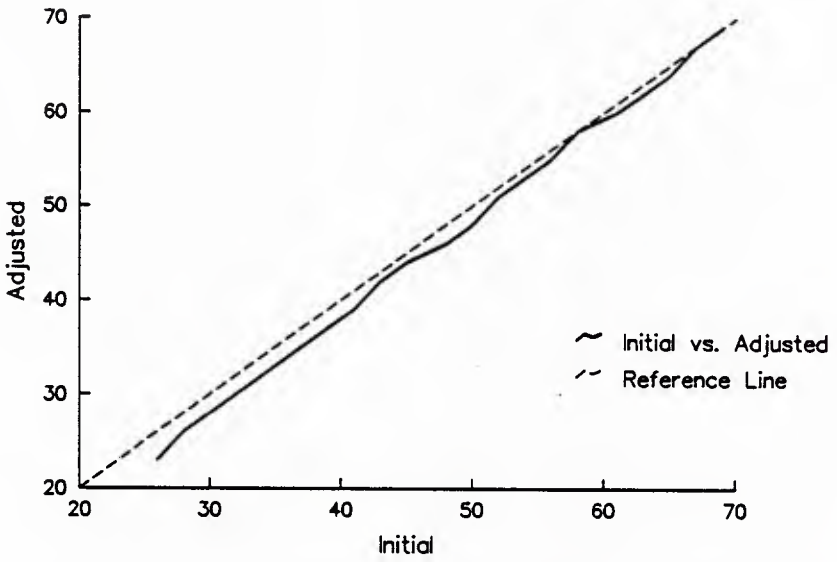

FIG. 15: INITIAL vs. ADJUSTED SCALING FOR ELECTRONICS INFORMATION SUBTEST

because the AFQT includes the Word Knowledge and Numerical Operations subtests. Results for the GT composite were also higher since Word Knowledge and Mechanical Comprehension are among the subtests included in this composite. The MM composite remained steady because the Mechanical Comprehension and Electronics Information subtests had opposite effects. The same is true for the CL composite, in which the Coding Speed and Word Knowledge subtests had opposite effects. The EL composite scores declined under the new equating because it includes the General Science and Electronics Information subtests.

TABLE 2

ASVAB SUBTESTS INCLUDED IN THE COMPOSITES EXAMINED

AFQT	GT	EL	MM	CL
WK	WK	GS	AR	WK
PC	PC	AR	AS	PC
AR	AR	MK	MC	MK
NO	MC	EI	EI	CS

NOTE: WK = Word Knowledge
PC = Paragraph Comprehension
AR = Arithmetic Reasoning
NO = Numerical Operations
MC = Mechanical Comprehension
GS = General Science
MK = Mathematics Knowledge
EI = Electronics Information
AS = Auto and Shop Information
CS = Coding Speed.

SUMMARY

ASVAB forms 11, 12, and 13 were implemented initially with score conversion tables developed using ASVAB score data gathered in the MEPSs and RTCs. Analysis of data gathered during the Initial Operational Test and Evaluation of these ASVAB forms showed that, because of a change in print formats of the test booklets, an adjustment in scaling was needed. The revised format adversely affected AFQT scores, primarily because of deflated scores on the Numerical Operations subtest. Thus, the Numerical Operations scores were adjusted upward in the revised scaling. However, this report shows that scores changed noticably for other subtests as well.

Comparison of the initial scaling with the adjusted scaling showed that scores were noticably higher under the adjusted scaling for the Word Knowledge, Numerical Operations, and Mechanical Comprehension subtests. Scores were noticably lower under the adjusted scaling for the General Science, Coding Speed, and Electronics Information subtests.

One effect of the adjusted scaling is to raise the reported quality of new accessions as measured by AFQT category. Changes in score distributions for other composites also occurred. These changes are illustrated by the FY 1985 Marine Corps applicant sample: The number of applicants qualifying at an AFQT percentile level of 50 increased by 2.1 percent. This sample also showed changes in number of applicants achieving aptitude composite scores; these ranged from an increase of 2.4 percent in those qualifying at a General Technical composite standard score of 100 to a decrease of 2.0 percent in those qualifying at the same standard score on the Elecronics Repair composite.

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[1] Air Force Human Resources Laboratory, TR-85-16, *Armed Services Vocational Aptitude Battery: Development of Forms 11, 12, and 13*, by J. Stephen Prestwood, C. David Vale, Randy H. Massey, and John R. Welsh, Unclassified, Sep 1985

[2] Joint-Service Selection and Classification Working Group Subcommittee, *A Review of the Development and Implementation of ASVAB Forms 11, 12, and 13*, by Major Larry Jurica, C. R. Hoshaw, Clessen Martin, Major Bill Strickland, and Major John Welsh, Unclassified, May 1986

[3] Office of the Secretary of Defense, *Conversion Tables Armed Services Vocational Aptitude Battery (ASVAB) Forms 11-12-13-14*, DOD 1304.12W, Oct 1984

[4] Office of the Secretary of Defense, *Conversion Tables Armed Services Vocational Aptitude Battery (ASVAB) Forms 11-12-13-14*, DOD 1304.12W, Jul 1986

APPENDIX A

CALIBRATION OF NEW ASVAB FORMS

APPENDIX A

CALIBRATION OF NEW ASVAB FORMS

When a new form of ASVAB (e.g., 11a) is introduced, it has to be calibrated—that is, new scores must be converted to equivalent scores on the reference form 8a. The new form and the reference form are administered to equivalent samples from a calibration group (e.g., recruits or applicants). Let $\bar{X}_{new}$ and S_{new} be the mean and standard deviation of the new form in the calibration sample, and let $\bar{X}_{ref}$ and S_{ref} be the corresponding values for the reference form. Each integer raw score on the new form is converted into an equivalent raw score on the reference form using the following equation:

$$RAW_{ref} = \bar{X}_{ref} + S_{ref}(RAW_{new} - \bar{X}_{new}) / S_{new} \quad .$$

There is no rounding at this stage of the calculation. Each RAW_{ref} can then be converted to a standard score based on the 1980 Youth Population scores on the reference form.

Table A-1 lists the means and standard deviations found in [A-1] through [A-3] that were used in this report to find the values of RAW_{ref}. Note that separate means and standard deviations are listed for form 12a, because the Joint-Service Selection and Classification Working Group (JSSCWG) determined that form 12a was not parallel to 11a, 11b, 12b, 13a, and 13b. The JSSCWG considered these other five forms sufficiently parallel to allow one score conversion for all five.

TABLE A-1

VALUES USED IN CONVERTING RAW SUBTEST SCORES TO EQUIVALENT SCORES ON THE 1980 YOUTH POPULATION METRIC

	$\bar{X}_{new}$		S_{new}		$\bar{X}_{ref}$		S_{ref}	
Subtest	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted	Initial	Adjusted
				ASVAB forms 11a, 11b, 12b, 13a, 13b				
GS	16.179	16.376	5.078	5.033	15.978	15.933	4.446	4.430
AR	18.904	18.976	6.918	6.628	17.634	17.813	6.553	6.453
NO	33.415	37.005	8.713	8.793	33.694	38.579	9.242	8.745
CS	44.711	50.065	13.138	13.018	44.884	49.104	13.451	12.788
AS	15.860	15.587	5.619	5.515	15.577	15.488	5.222	5.189
MK	12.681	12.873	5.910	5.938	12.963	13.172	5.459	5.569
MC	15.475	15.293	4.988	4.821	14.509	15.080	5.026	5.082
EI	11.703	12.032	4.121	4.027	12.099	11.895	3.838	3.879
VE[a]	36.344	36.599	9.626	9.415	37.376	37.908	8.504	8.193
				ASVAB form 12a				
GS	17.051	16.695	4.450	4.746	16.985	15.933	4.161	4.430
AR	19.194	19.020	6.191	6.526	18.197	17.813	6.387	6.453
NO	33.556	34.689	9.063	8.974	36.333	38.579	9.144	8.745
CS	47.093	50.047	14.252	13.233	47.283	49.104	13.994	12.788
AS	15.800	15.098	5.420	5.610	16.335	15.488	5.022	5.189
MK	12.965	12.587	5.917	6.258	13.278	13.172	5.343	5.569
MC	15.291	15.309	5.105	4.892	14.816	15.080	5.158	5.082
EI	12.793	12.473	4.033	4.051	12.504	11.895	3.834	3.879
VE[a]	37.227	35.689	8.547	9.472	38.660	37.908	7.699	8.193

a. Note that VE = WK + PC.

REFERENCES

[A-1] CNA, Memorandum 85-2352, *Computation of ASVAB Subtest and Aptitude Composite Standard Scores*, by Milton H. Maier, Unclassified, 2 Jan 1986

[A-2] Assessment Systems Corporation, letter from Marcia M. Andberg, 22 Jan 1986

[A-3] Assessment Systems Corporation, letter from Marcia M. Andberg, 29 Jan 1986